THE LARVA OF *SYNTHEMIS LEACHI* SELYS, WITH A KEY TO THE LARVAE OF WESTERN AUSTRALIAN SYNTHEMIDAE (ODONATA)

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INTRODUCTION

The dragonflies of the genus *Synthemis* and its allies constitute an important part of the primitive dragonfly fauna of the Australian region (Tillyard, 1917). Four species are known from Western Australia, and all are confined to the extreme south-west: *Synthemis leachi* Selys, 1871, *C. cyanitineta* Tillyard, 1908, *S. maerostigma occidentalis* Tillyard, 1910, and *S. spiniger* Tillyard, 1913. Watson (1962) keyed the larvae of the last three species, but the larva of *S. leachi* was then unknown.

Late in December, 1965, abundant *S. leachi* were discovered in a swamp and small stream on the western edge of Waroona. Mature adults, a newly-emerged adult associated with a fresh synthemid exuviae and a half-grown larva were collected.

During the ensuing month similar exuviae were collected near Dwellingup and Karridale, and further larvae and exuviae were found at Waroona. A comparison of these specimens with existing larval material showed that a larva of the same type had been collected at Araluen in May, 1958, but had passed unrecognised.

STRUCTURE OF THE LARVA

Like the larvae of other synthemids, the immature *S. leachi* is heavily built and relatively short-legged, a hurrower, and has diverging wing sheaths and a deep, concave labial mask which lacks setae on the distal border of the palp (figs. 1, 6; cf. figs. 46-51 in Watson, 1962). *S. leachi* resembles most closely the larva of *S. maerostigma* and is difficult to distinguish from it; the body is hairy, the labial palp bears large, jagged teeth, the frontal plate is small (fig. 7) and the paraprocts and epiproct are long (figs 1, 8). The larva is, however, larger than that of *S. maerostigma*, and the colour pattern, the armature of the labial mask, the pattern of hairiness and the structure of the anal appendages differ from those of the smaller species. It is therefore most convenient to summarize the description of the larval *S. leachi* in a table of comparison with *S. macrostigma occidentalis* (Table 1).

MATERIAL

Unless otherwise specified, all material was collected by the author. *Synthemis leachi* (21 specimens): 1 3-ult. larva† Araluen, 11.v.1958; 15 2- to 4-ult larvae, 3 exuviae, Waroona, 23.xii.1965,

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†i.e., third-last stage larva.

2 and 23.i.1966; 1 exuviae, 1 m. S.W. old Karridale site, 29.xii.1965; 1 exuviae, 4 m. E. Dwellingup, 2.i.1966. *Synthemis macrostigma occidentalis* (60 specimens): 5 3-ult. larvae, side stream of Helena River, Darlington, 5.ix.1953 and 1.vi.1954, E. P. Hodgkin; 1 ult. larva Nyaania Brook, Darlington, 29.viii.1956; 7 4- to 2-ult. larvae, Cape Leeuwin swamp, 19.iv.1957; 1 2-ult. larva, Flinders Bay, 19.iv.1957; 36 exuviae, clay pit on Lesmurdie Road, Lesmurdie, 29.xi.1957; 3 2-ult. larvae, Jacky-Jacky Spring, Dalyup River, 3.iv.1958; 1 2-ult. larva, 1.75 m. S.W. Karragullen, 11.v.1958; 5 exuviae, Bull Creek, Riverton, 13.xi.1965; 1 ult. larva, Crystal Brook, Lesmurdie, 3.i.1966.

ECOLOGY OF *SYNTHEMIS LEACHI*

Synthemis leachi breeds in streams and bogs, and almost certainly in lakes. The larvae at Araluen and Waroona were collected from pockets of muddy leaf litter in streams, whereas the exuviae at Karridale and Dwellingup were found on low tussocks in extensive boggy marshes. The fact that Tillyard (1908) reported *S. martini*, a synonym of *S. leachi*, at Lake Monger suggests that the species breeds in lakes, or in bogs adjacent to them; and the species is common in the swampy lakes behind Myalup Beach. The known distribution of the species closely follows that of the permanent streams, and extends from Perth to the Kalgan River.

Three observations, taken together, indicate that the life cycle occupies two years. First of all, the adult season starts during November and closes about the end of February (Watson, 1962). Secondly, the larvae collected at Waroona in December were all rather more than half grown. Had they developed from eggs laid in the current adult season, they would have had to hatch and pass through at least six instars in less than two months. Thirdly, the penultimate larval stage of *S. leachi* exceeds 65 days in the laboratory; and the last larval stage of the allied *S. macrostigma* occupies approximately 80 days at 15° to 21° C., the temperatures prevailing in streams during summer, and the earlier stages, from 4-ult. to 2-ult., range from 30 to 60 days (Watson, unpublished data).

Despite the long life cycle and the coincidence of the known range with that of permanent streams, *Synthemis leachi* may associate with streams and bogs that are dry in summer (cf. Tillyard, 1908). Thus the marsh at Karridale is temporary, although the peaty mud remains damp throughout the summer; and the nearest permanent water is more than a quarter of a mile away (L. M. O'Halloran, personal communication).

Furthermore, the females will lay eggs in dry environments. *S. leachi* is abundant in a swamp at the foot of the Whicher escarpment on the road from Busselton to Nannup. This swamp is drained by a channel similar to the stream at Waroona, and is dry in summer. Late in December, 1965, adults were pairing and females were laying eggs in depressions in damp mud. Although this oviposition may be abortive, it is clear that damp mud appears a suit-

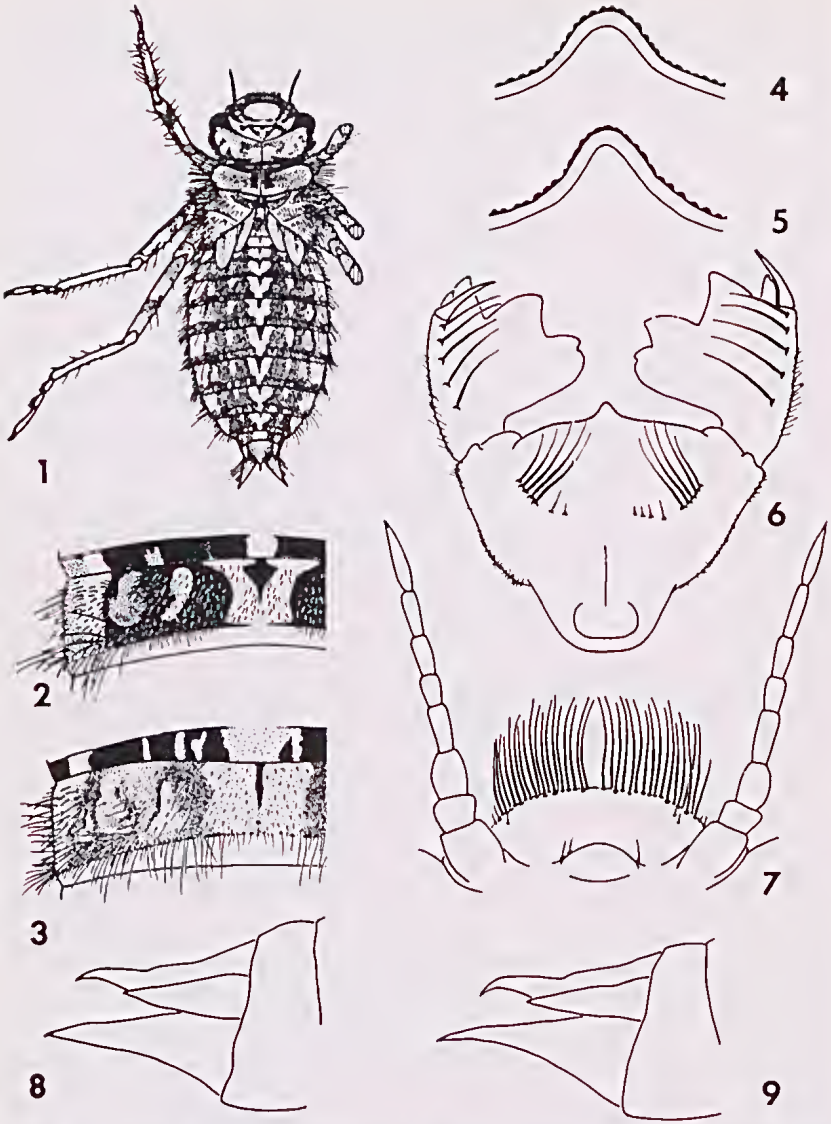

Fig. 3. 3-ult. larva of *Synthemis leachi* (from life), x approx. 3.5.
2. Abd. 6 of a 3-ult. larva of *S. leachi*.
3. Abd. 6 of a last stage larva of *S. macrostigma occidentalis*.
4. Ligula from a final exuviae of *S. macrostigma occidentalis*.
5. Ligula from a final exuviae of *S. leachi*.
6. Labium from a final exuviae of *S. leachi*, x approx. 7.
7. The antennae and frontal plate of a 3-ult. larva of *S. leachi*.
8. Terminal appendages of mature larval *S. leachi*, lateral view x approx. 14.
9. Terminal appendages of mature larval *S. macrostigma occidentalis*, lateral view x approx. 14.

able habitat to the adult, even when a flowing stream is available within a few yards.

The question then arises: Do the larval stages occupy these dry environments throughout the year, or do they migrate there from permanent refuges when the swamps refill with the first rains? That they might survive the summer is suggested by the observation of Tillyard (1910) that larvae of the eastern *Synthemis eustalacta* can tolerate drying in sand.

Sieving a sample of mud from Karridale has failed to yield larvae. However, direct experiments have shown that the larvae can survive for long periods in the absence of free water.

Samples of 4-ult. to 2-ult. larvae from Waroona were placed in open jars with sand and leaf litter covered with a few millimetres of water, and were held at room temperature. After five days the free water (i.e., water that would separate from the litter when the jar was tipped) had disappeared, and the larvae had buried themselves shallowly. The single 4-ult. larva survived a further four weeks, and the 2-ult. larvae lasted for five. By this time the litter in the two jars had a moisture content of only 6.6 and 7% (assayed in a Carter-Simon rapid moisture tester at 140° C.), providing a relative humidity of 25 and 35% at the surface and 32 and 48% in the litter (measured with a Honeywell W611A R.H. indicator).

Four of five 3-ult. larvae in a third jar, however, were still alive after five weeks; the litter felt damp to the touch, had a moisture content of 61.2% and provided a relative humidity of approximately 50% at the surface (where the larvae were) and approaching saturation in the sand. When replaced in water, the larvae initially floated and then, once the cuticle had become wet and free of bubbles, swam to the bottom and commenced to feed.

Thus, although the larvae will not tolerate dehydration (i.e., they are not cryptobiotic), they can survive for long periods in damp soil, which could permit their utilization of summer-dry bogs. In this they differ greatly from the species commonly breeding in shallow, ephemeral ponds—for example, *Anax papuensis* and *Hemicordulia tau*—which cannot tolerate drying (Hodgkin and Watson, 1958; Watson, 1962).

KEY TO THE LARVAE OF WESTERN AUSTRALIAN SYNTHEMIDAE

Synthemis leachi and *S. macrostigma occidentalis* are indistinguishable in the larval key of Watson (1962). A new key to the Western Australian synthemids, commencing at couplet 20 of the earlier work, is given below. References to figures in Watson (1962) are omitted.

20 (19). Distal border of labial palp bearing small, rounded teeth; prominent frontal plate projecting between bases of antennae.

Synthemis cyanitincta Tillyard.

Distal border of labial palp bearing large, jagged teeth (fig. 6); frontal plate small (fig. 7) 21

21 (20). Upper surfaces of abdomen sparsely haired, lacking row of long hairs on posterior border of segments, or on dorso-lateral surface.

Synthemis spiniger Tillyard.

Upper surface of abdomen set with dense traverse rows or dorso-lateral patches of hair 21a

21a (21). Abdomen with or without inconspicuous pale mid-dorsal line (absent from exuviae) (fig. 3); major mental setae generally 6, minor mental setae generally 6 or 7; top of abdomen sparsely set with short, pale setae, densely set with long setae on posterior border and dorso-lateral surface of each segment (fig. 3); mature larva 19-23 mm.

Synthemis macrostigma occidentalis Tillyard.

Abdomen with conspicuous pale mid-dorsal line, appearing as a series of "V" marks (absent from exuviae) (figs. 1, 2); generally 5 major and 4 or 5 minor mental setae (fig. 6); top of abdomen densely set with short, dark setae, posterior border of segments almost devoid of long setae but dorso-lateral patches present (figs. 1, 2); mature larva 25-28 mm.

Synthemis leachi Selys.

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TABLE 1.—Comparison of larval Synthemis leachi and S. macrostigma occidentalis. (Setal counts give the number of setae and, in parentheses, the number of observations; heavy type indicates the modal counts).

Character		S. leachi	S. macrostigma
Length (ult. larva):	mean	26.4 mm.	20.95 mm.
	range	25-28 mm.	19.5-22.5 mm.
Head:	frontal plate	small (fig. 7)	as S. leachi
	antennae	segts. 4 and 5 < segts. 6, 7 (fig. 7)	as S. leachi
Labium:	palp: distal border	3 major, jagged teeth (fig. 6)	as S. leachi
	palp: setae	5 (20)	3(1): 4(6): 5(107): 6(5): 7(1)
	ligula (ult. larva)	sharply protruding (fig. 5)	more rounded (fig. 4)
	mental setae: major	5(17): 6(3)	5(5): 6(103): 7(11)
	mental setae: minor	2(1): 4(11): 5(7): 6(1)	4(2): 5(13): 6(53): 7(36): > 8(11)
Thorax:	prothorax (may be obscured with dirt)	lateral edge of pronotum set with comb of regular, stiff dark setae; anterior lobe set with dense, short setae (fig. 1)	lateral edge of pronotum set with comb of pale, soft setae; anterior lobe bare or with few pale setae
	synthorax (may be obscured with dirt)	set with many short, dark, stiff setae (fig. 1)	set with few pale, short setae
Abdomen:	colour (not shown by exuviae)	prominent pale mid-dorsal stripe, flecked black in mid-line, appearing as "V" marks on Abd. 5-8 (figs. 1, 2)	inconspicuous dorsal stripe, without appearance of "V" marks (fig. 3)
	setae (may be obscured with dirt)	set with dense pile of short, dark setae; long setae on dorso-lateral surface (figs. 1, 2)	set with few short, pale setae; long setae dorso-laterally and on posterior edge of each segment (fig. 3)
Anal appendages:		tip of epiproct slightly downturned (fig. 8)	tip of epiproct sharply downturned (fig. 9)